

REMARKS

By this Amendment, Claims 1 and 10 have been amended; and new Claims 21-24 have been added, leaving Claims 1-24 pending. Claim 1 has been amended to incorporate subject matter of Claim 10 and to recite an oxygen-free etching gas. Support for an oxygen-free etching gas can be found in the specification at page 15, lines 4-5 and in Table 4. New Claim 21 recites a mask layer comprising a doped oxide, undoped oxide, silicon nitride, silicon carbide, silicon oxynitride and combinations thereof. Support for this change can be found in the specification at page 5, lines 10-12. New Claim 22 recites a process for etching a low-k dielectric layer with an etching gas comprising C_4F_8 , CF_2H_2 , N_2 and optionally Ar, the C_4F_8 , CF_2H_2 and N_2 being supplied to the chamber at flow rates such that the total C_4F_8 and CF_2H_2 flow rate is less than the N_2 flow rate, and new Claim 23 recites a process wherein the flow rate of the CF_2H_2 is less than or equal to the flow rate of the C_4F_8 . Support for these changes can be found in the specification at page 23, lines 12-16 and Table 4. No new matter has been added by this amendment. Reconsideration of the September 24, 2003 Official Action is respectfully requested.

The process of the invention can be carried out in a parallel plate plasma reactor such as reactor 200 shown in Fig. 5 (specification at page 12, lines 19-20). Etching gas can be supplied to a showerhead electrode by supplying gas from a gas supply 206 and a medium density plasma can be generated in the reactor by a dual frequency arrangement wherein RF energy from RF source 208 is supplied to a match network 210 to the showerhead electrode 212 and RF energy from RF source 214 is supplied through a match network 216 to a bottom electrode 218 (specification at page 12, line 22 through page 13, line 4). Alternatively, the showerhead electrode 212 can be electrically grounded and RF energy at two different frequencies can be supplied to the bottom electrode 218 (specification at page 13, lines 5-6). A substrate 220 supported on the bottom electrode 218 can be etched with plasma generated by energizing the etch gases into a plasma state (specification at page 13, lines 6-8). In etching a low-k dielectric layer using a gas mixture

containing fluorocarbon, nitrogen and optional gases such as a carrier gas energized into a plasma state such that the fluorocarbon and the nitrogen reactant are at least partially dissociated, the fluorine and the carbon reacts with some free F to thereby reduce the etch rate of the masking and/or stop etch layers (specification at page 13, lines 11-18). The nitrogen is effective in providing a desired level of selectivity between the etch rates of the low-k dielectric material and an overlying mask layer (e.g., silicon dioxide, silicon oxynitride, silicon nitride), a desired selectivity to an underlying etch stop layer (e.g., silicon carbide, silicon nitride) and/or a desired selectivity to an overlayer such as a photoresist while at the same time balancing polymer build-up sufficiently to protect sidewalls of etched features while avoiding pinch-off and etch stop problems due to excessive polymer build-up (paragraph bridging pages 13-14). For a medium density plasma produced in a parallel plate reactor, advantageous effects can be achieved by supplying the nitrogen reactant and fluorocarbon reactant such that the flow rate of the fluorocarbon is less than that of the nitrogen (specification at page 14, lines 13-22). Preferably, the etched gas is oxygen-free to void attack of a stop layer such as silicon carbide by the oxygen (specification at page 15, lines 3-5).

1. Rejection of Claims 1-20 under 35 U.S.C. § 112, second paragraph

Claim 1, and by virtue of their dependency on Claim 1, Claims 2-20 were rejected for allegedly lacking sufficient antecedent basis for the term "organosilicate layer." Claim 1 has been amended to change "organosilicate" to --low-k dielectric-- and thereby overcome the rejection.

2. Rejection of Claims 1, 3-7, 11 and 13-17 under 35 U.S.C. §102 (e)

Claims 1, 3-7, 11 and 13-17 were rejected under 35 U.S.C. §102(e) over U.S. Patent No. 6,248,149 to Li ("Li"). The reasons for the rejection are stated at pages 2-3 of the Official Action. The rejection is respectfully traversed.

Claim 1 has been amended to include features recited in original Claim 10. As Claim 10 was not rejected under this ground of rejection, the rejection of Claim 1 is deemed moot.

Claims 3-7, 11 and 13-17 depend from Claim 1; accordingly, the rejection of these claims is moot.

Withdrawal of the rejection is respectfully requested.

3. Rejection of Claims 1-6, 9, 11-12 and 14-16 under 35 U.S.C. §102

Claims 1-6, 9, 11-12 and 14-16 were rejected under 35 U.S.C. §102(e) over U.S. Patent No. 6,455,411 to Jiang ("Jiang"). The reasons for the rejection are stated at page 3 of the Official Action. The rejection is respectfully traversed.

Claim 1 has been amended to include features recited in original Claim 10. As Claim 10 was not rejected under this ground of rejection, the rejection of Claim 1 is deemed moot.

Claims 2-6, 9, 11-12 and 14-16 depend from Claim 1; accordingly, the rejection of these claims is moot.

Withdrawal of the rejection is respectfully requested.

4. Rejection of Claims 8-10, 12 and 19-20 under 35 U.S.C. §103

Claims 8-10, 12 and 19-20 were rejected under 35 U.S.C. §103(a) over Li. The reasons for the rejection are stated at pages 4-5 of the Official Action. The rejection is respectfully traversed.

Claim 1, on which Claims 8-10, 12 and 19-20 depend, recites, inter alia, a process for etching a low-k dielectric layer with selectivity to an overlying mask layer, comprising supplying an oxygen-free etching gas to the chamber and energizing the etching gas into a plasma state wherein the plasma etch reactor comprises a dual frequency parallel plate plasma reactor having a showerhead electrode and a bottom electrode. Li does not disclose or suggest an oxygen-free etching gas or etching a low-k dielectric layer in a dual frequency parallel plate plasma reactor. In Li, "the etching gas includes a fluorocarbon gas, an oxygen-containing gas, such as oxygen, and nitrogen." (Li at column 5, lines 28-33). Furthermore,

in each of the examples of Li, the etch recipe for etching the exemplary low-k dielectric of Li (BCB) comprises oxygen (See Tables 1-2, 4-7). Accordingly, Claim 1 and the claims dependent thereon are patentable over Li.

Claim 22 recites a process for etching a low-k dielectric layer with selectivity to an overlying mask layer, comprising the steps of supporting a semiconductor substrate in a chamber of a plasma etch reactor, the semiconductor substrate having a low-k dielectric layer and an overlying mask layer, supplying an etching gas to the chamber and energizing the etching gas into a plasma state, the etching gas comprising C_4F_8 , CF_2H_2 , N_2 and optionally Ar, the C_4F_8 , CF_2H_2 and N_2 being supplied to the chamber at flow rates such that the total C_4F_8 and CF_2H_2 flow rate is less than the N_2 flow rate and the flow rate ratio of the fluorocarbon reactant to the nitrogen reactant is 30% or less, and etching exposed portions of the low-k dielectric layer with the plasma so as to etch openings in the low-k dielectric layer with the plasma while providing a etch rate selectivity of the etching rate of the low-k dielectric layer to the etching rate of the mask layer of at least about 5. Li fails to suggest etching a low-k dielectric layer using an etching gas comprising C_4F_8 , CF_2H_2 and N_2 wherein the flow rates of C_4F_8 and CF_2H_2 is less than the N_2 flow rate and wherein the flow rate ratio of the fluorocarbon reactant to the nitrogen reactant is 30% or less. Accordingly, Claims 22-24 are patentable over Li.

Withdrawal of the rejection is respectfully requested.

5. Rejection of Claim 18 under 35 U.S.C. §103

Claim 18 was rejected under 35 U.S.C. §103(a) over Jiang. The reasons for the rejection are stated at page 6 of the Official Action. The rejection is respectfully traversed.

The Official Action asserts that it would have been obvious to use an etchant consisting of C_5F_8 , N_2 and Ar because "Jiang teaches using an etchant consisting of C_4F_8 , N_2 and Ar and Jiang also teaches that C_4F_8 and C_5F_8 are functional equivalents."

Claim 1 has been amended to include features recited in original Claim 10. As Claim 10 was not rejected in view of Jiang, the rejection of Claim 18, which depends from Claim 1, is moot.

Withdrawal of the rejection is respectfully requested.

6. Conclusion

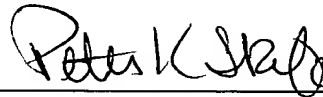
For at least the foregoing reasons, it is submitted that the application is in condition for allowance and such action is earnestly solicited.

Respectfully submitted,

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